



DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

1400 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22209



ARPA Order No. 3549
Program Code No. 8T10
Program Element Code: 62708E
Industrial Priority Rating: DO

January 16, 1978

Department of the Army
U.S. Army Materiel Development
and Readiness Command
5001 Eisenhower Avenue
Alexandria, Virginia 22304

Attention: DRCDE-P

1. It is requested that the U.S. Army Electronics Command (ECOM) use the \$160,000 provided herein to negotiate an 8-month contract with Network Analysis Corporation for research on Ground Packet Radio Data and Voice Systems and Analysis Design in support of the DARPA/Army Packet Radio Testbed program in general accordance with the restructured Task 1 covered under the 8 December 1977 Amendment of their Proposal No. 2671, dated July 1977. Remaining Tasks will not be funded by DARPA, however, it is understood that ECOM may elect to fund Task 3 directly. The total estimated cost of the DARPA funded portion of this contract should not exceed \$204,277. Partial (fiscal year) funding techniques will be used by DARPA and a "Limitation of Funds" clause should therefore be included in the contract.
2. Statement of Work: A contractual work statement consistent with that set forth in Section 1.1 of the above cited proposal is requested.
3. Relevance to the DoD/DARPA Mission and Functions: The use of packet radio by the field Army requires a methodology for its deployment. This work seeks such a deployment strategy and an analysis of it for several key operation scenarios.
4. The funds provided herein are designed to support a planned period of research performance ending on or before 30 September 1978. In no case will this funded period extend beyond 15 December 1978 without the prior approval of DARPA.

ARPA Order No. 3549

5. It is requested that DARPA be kept informed of the status of work under the Order by means of Quarterly R&D Status Reports, Mid-term Technical, and Final Technical reports. These reports are to be prepared and submitted in accordance with the instructions attached to our memorandum of 1 July 1976, subject: "Revised ARPA Order General Requirements."

6. This Order makes available \$160,000 under appropriation and account symbol "9780400.1301 Research, Development, Test and Evaluation, Defense Agencies," for obligation on behalf of DARPA only for the purposes specified herein. These funds are immediately available and are not for the construction of facilities.

7. The General Requirements, as stated in the attachment to the DARPA memorandum of 1 July 1976, are included herein by reference.

Carl F. Romney
for Robert R. Fossum
Director

Attachment (ECOM only)

- a. Selected Source Justification
- b. NAC Proposal 2671 dated July 1977
as amended 8 December 1977

ARPA Order No. 3549

PROJECT OFFICE: IPTO

P. MANAGER: Col Russell x-44001

PROGRAM: T16 - Army C3 Experiment Testbed NSF Codes: 5-A-23-33

Deployment strategies for packet radio equipment

AGENT: ECOM

FUNDING HISTORY:	<u>Prior Years</u>	<u>FY-1</u>	<u>FY78</u>	<u>FY+1</u>	<u>To Completion</u>
Program:	-0-	-0-	701K	2,720K	2,400K
Task:	-0-	-0-	160K	100K	-0-

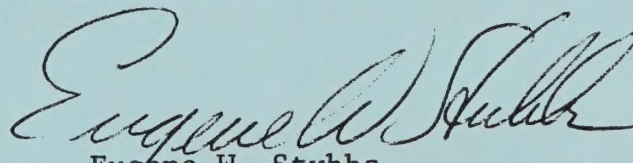
THIS ACTION:

<u>Line</u>	<u>Performer</u>	<u>Type Action</u>	<u>Mos Term</u>	<u>Inclusive Dates</u>	<u>FY78 Commit</u>	<u>FY79 Due</u>
T16004	NAC	CON	6	4-1-78/9-30-78	160,000	44K

JOINT FUNDING:	<u>Service/Agency</u>	<u>FY78 Commit</u>	<u>FY79 Due</u>
	DARCOM	-0-	-0-

REMARKS: This is a joint DARPA/DARCOM (See MOU attached to MRAO) program for a cooperative effort of technology transfer relating to potential tactical applications of the Packet Radio system. DARCOM funding proposed in the MOU is for acquisition of Packet Radio and is applied to effort in that program area.

This effort funds Task 1 of contractor's proposal only, as specified in the ARPA Order.


 Eugene W. Stubbs
 Program Management Officer
 January 11, 1978



DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

1400 WILSON BOULEVARD
ARLINGTON VIRGINIA 22209

ARPA Order No. 3549
Amendment No. 1
Program Code: 8T10
Program Element Code: 62708E
Industrial Priority Rating: DO

AUG 16 1978

Commander
U.S. Army Materiel Development
and Readiness Command
5001 Eisenhower Avenue
Alexandria, Virginia 22333

Attention: DRCDE-P

1. In accordance with contractual data provided to DARPA, this Amendment withdraws unobligated funds in the amount of \$130,000 under appropriation and account symbol "9780400.1301 Research, Development, Test and Evaluation, Defense Agencies." This brings the funding under this Order to a new total of \$30,000 to date.
2. These funds are being concurrently committed under ARPA Order 2948.
3. It is DARPA's intent, subject to the availability of appropriations, to replace the funds withdrawn in early FY79.
4. It is requested that you indicate acceptance of this Amendment by returning two signed copies to:

Director, Program Management Office
Defense Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, Virginia 22209

5. The DARPA point of contact on questions regarding this WITHDRAWAL is Eugene W. Stubbs (202) 694-1588 or Autovon 8-224-1588.

David R. Braunstein
David R. Braunstein
Director
Program Management Office

YOU ARE REQUESTED TO ACKNOWLEDGE RECEIPT AND ACCEPTANCE OF THIS WITHDRAWAL BY SIGNING TWO COPIES AND RETURNING TO DARPA.

Roy D. Green
Name

17 AUG 1978
Date

**DEFENSE ADVANCED RESEARCH PROJECTS AGENCY**

1400 WILSON BOULEVARD
ARLINGTON VIRGINIA 22209

ARPA Order No. 3549
Amendment No. 2
Program Code No. 9T10
Program Element Code: 62708E
Industrial Priority Rating: DO

29 AUG 1978

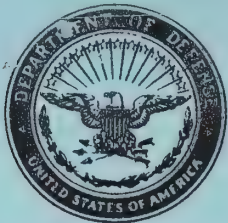
Commander
U.S. Army Materiel Development
and Readiness Command
5001 Eisenhower Avenue
Alexandria, Virginia 22333

Attention: DRCDE-P

1. It is requested that the U.S. Army Communications Research and Development Command (CORADCOM) use the \$174,000 provided herein to complete the funding of the Contract with Network Analysis Corporation to be requested under this Basic Order.
2. The funds provided in this Amendment are designed to support a planned period of research performance ending 30 September 1979 or earlier. In no case will this period be extended beyond 15 November 1979 without prior approval of DARPA.
3. The fund availability is hereby increased by \$174,000 under appropriation and account symbol "9790400.1301 Research, Development, Test and Evaluation, Defense Agencies" for direct obligation ON or AFTER 1 October 1978. This brings the funding under this Order to a new total of \$204,000 to date.
4. All other terms and conditions remain unchanged by this Amendment.

A handwritten signature in cursive script, reading "Eugene H. Fossum", is written over the typed name.

Robert R. Fossum
Director



DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

1400 WILSON BOULEVARD
ARLINGTON VIRGINIA 22209

2 MAR 1981

ARPA Order No. 3549
Amendment No. 4
Program Code No. OT10
Program Element Code: 62708E
Industrial Priority Rating: DO

Commander
U.S. Army Materiel Development
and Readiness Command
5001 Eisenhower Avenue
Alexandria, Virginia 22333

Attention: DRCDE-P

1. It is requested that the U.S. Army Communications Research and Development Command (CORADCOM) use the \$6,998.00 provided herein to fund the overrun incurred under Contract No. DAAK80-79-C-0763 with Network Analysis Corporation, in accordance with the Contracting Officer's memorandum of January 16, 1981.
2. The fund availability is hereby increased by \$6,998.00 under appropriation and account symbol "9700400.1301 Research, Development, Test and Evaluation, Defense Agencies" for direct obligation on behalf of DARPA only in the amount and for the purpose specified herein. This brings the funding under this Order to a new total of \$210,533 to date.
3. All other terms and conditions remain unchanged by this Amendment.

A handwritten signature in dark ink, appearing to read "Ray E. Chapman", is positioned above the typed name.

- Ray E. Chapman
Director
Program Management

810570 IPTO
ARPA Order No. 3549/4 *Leine*

Chronology of AO Actions

BL 2-26 XP2-26

DATES		DATES	
2-26	MRAO Rec'd in PM		AO Ret'd from Dir to Tech Off thru PM
	Resubmission (MRAO) Rec'd in PM		Resubmission Rec'd in PM
2-27	Fw'd to Dir for Signature		Resubmission to Director
3-2	Ret'd from Director's Office		Ret'd from Director's Office

MR. CHAPMAN

ARPA ORDER FOR MR. CHAPMAN'S SIGNATURE.

FMD COORDINATION.

LC 3/2

MR. ROMNEY

MR. FOSSUM

This ARPA Order/ARPA Order Amendment
has been signed and shown to the undersigned.

[Signature]
Program Management Officer

3/2/81
Date

mailed 24 Mar, 78

SUMMARY SHEET

ARPA Order No. 3549

Amendment No. 4

PROJECT OFFICE: IPTO

P. MANAGER: Dr. Leiner, X45918

NSF CODES: No Change

PROGRAM: COST GROWTH - Army C³ Experiment Testbed

Deployment strategies for packet radio equipment

AGENT: CORADCOM

FUNDING HISTORY:	<u>Prior Years</u>	<u>FY80</u>	<u>FY81</u>	<u>FY82</u>	<u>FY83</u>
Program:	2998	2031	2075	2700	1650
Task:	364	7	0	0	0

THIS ACTION:

<u>Line</u>	<u>Performer</u>	<u>Type Action</u>	<u>Mos. Term</u>	<u>Inclusive Dates</u>	<u>FY80 Commit</u>
T160102	NAC	CONADD	N/A	FY 1980	\$6,998.00

REMARKS:

1. This action funds an overrun incurred by the contractor for computer time and final report editing not previously billed. No fee is included in this amount.
2. By TENEX note of 1/16/81, the Contracting Officer confirmed the contractor's claim.

FY80 funds are available:

for Dr. 2/26/81
Chief, FMD

Eugene W. Stubbs
Eugene W. Stubbs
Program Management Officer
February 26, 1981
(b1)

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 2

1. AMENDMENT/MODIFICATION NO. P00001	2. EFFECTIVE DATE 24 Aug 79	3. REQUISITION/PURCHASE REQUEST NO. N/A	4. PROJECT NO. (If applicable)
5. ISSUED BY USA CORADCOM, Procurement Directorate Division D, Fort Monmouth, NJ 07703 Joseph Leone/DRDCO-PC-D(LEO) 201-532-3692	CODE W15BAY	6. ADMINISTERED BY (If other than block 5) DCASMA, Garden City 605 Stewart Avenue Garden City, L.I., NY 11530	CODE S3309A

7. CONTRACTOR NAME AND ADDRESS Network Analysis Corporation 130 Steamboat Road Great Neck, New York 11024 (Street, city, county, state, and ZIP Code)	CODE FACILITY CODE 8. AMENDMENT OF SOLICITATION NO. _____ DATED _____ (See block 9) MODIFICATION OF CONTRACT/ORDER NO. <u>DAAK80-79-C-0763</u> DATED <u>30 Jan 79</u> (See block 11)
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9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

N/A

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of agreement of both parties - Contractor's letter dated 20 Jul 79.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

THE CONTRACT IS AMENDED AS FOLLOWS:

SECTION E-SUPPLIES/SERVICES

CLIN 0001 - Delete "for a period of seven (7) months" and substitute "for a period of nine (9) months".

SECTION H - DELIVERY/PERFORMANCE

H.1 - Delete in its entirety and substitute the following:

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 1 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR BY <u>Arnold H. Levine</u> (Signature of person authorized to sign)	17. UNITED STATES OF AMERICA BY <u>Michael J. Pawlish</u> (Signature of Contracting Officer)
15. NAME AND TITLE OF SIGNER (Type or print) ARNOLD H. LEVINE V.P. FIN.	16. DATE SIGNED 9/12/79
18. NAME OF CONTRACTING OFFICER (Type or print) MICHAEL J. PAWLISH	19. DATE SIGNED 190879

Modification P00001
Contract DAAK80-79-C-0763
Page 2 of 2 pages

SECTION H - Continued

CLIN 0002/A001 - Block 10 "Wkly"
(35)

CLIN 0002/A002 - Block 10 "Mthly"
(8)

CLIN 0002/A003 - No change

CLIN 0002/A004 - No change

CLIN 0002/A005 - Draft - 15 Oct 79
Final - 15 Dec 79

This contract Modification P00001 does not effect the contract estimated cost or fixed fee.

All other terms and conditions remain unchanged.

Previous allotment No.

AA 9780400 1301 623549 8T10 2581 S28-043

AB 9790400 1301 96H-3549 9T10 2581 S28-043

JL/tlt

**DEFENSE ADVANCED RESEARCH PROJECTS AGENCY**

1400 WILSON BOULEVARD
ARLINGTON VIRGINIA 22209

31 JUL 1978

MEMORANDUM FOR DIRECTOR, PROGRAM MANAGEMENT OFFICE

SUBJECT: Request for FY1979 Incremental Funding Augmentation/
Completion Funding, Information Processing Techniques Office

I have reviewed the contractual and in-house efforts which were initiated prior to FY1979 and which span the FY1979 period. Listings of these efforts, by program, are provided on attachments to this memorandum. Each program is listed on a separate sheet. It is requested that the necessary ARPA Order(s) be prepared for the Director, DARPA, approval.

A handwritten signature in dark ink, reading "David C. Russell".

David C. Russell, Colonel, USA
Director
Information Processing Techniques
Office

Attachment:

T16 Army Tactical Information
Distribution Testbed

PROGRAM TITLE: T16 Army Tactical Information Distribution Testbed

<u>LINE #</u>	<u>AO</u>	<u>AGENT</u>	<u>PERFORMER</u>	<u>TERM (MOS)</u>	<u>FUND TO</u>	<u>FY79 COMMIT</u>	<u>FY80 DUE</u>
1.	T16008I	3372	DSSW	System Planning Corp.	12	31 Dec 78	30
							0
2.	T16002I	3534	DSSW	City College of New York	12	30 Sep 79	91
							0
3.	T16102I	3549	ECOM	Network Analysis Corp.	12	30 Jun 79	44
							0
1.	T16008I	SPC	ADDS Testbed Planning				

Accomplishments to date:

- Performed digital terrain analysis of the V U.S. corps area in Europe and illustrated applications of packet radio networks in support of a distributed corps headquarters and brigade communications, artillery fire support and air defense.
- Prepared preliminary concepts and plans for a packet radio testbed program at a corps base.
- Led a one week feasibility survey of the XVIII Airborne Corps Headquarters and subordinate units at Fort Bragg, North Carolina as a basis for selecting the XVIII Airborne Corps as the participating unit in the joint DARPA/Army tactical data distribution testbed program.
- Analyzed projected TRADOC and DARCOM requirements for tactical data distribution systems, XVIII Airborne Corps organization, functions and mission, and the expected availability of packet radios as the basis for the initial 18 month experiment program.

FY79 Objectives:

- Analyze proposed participation by XVIII Airborne Corps elements in the tactical data distribution testbed and prepare a plan for phased introduction of users beginning in Nov 78 and extending through Dec 79.

- Analyze proposed applications software supported by testbed resources to determine potential long-term impact on Army organization, policies and procedures.
- Evaluate XVIII Corps field operations to identify potential impact of proposed applications software implemented in garrison.
- Prepare study of Corps field operations under current communications support capabilities to form a base line from which to evaluate impact of packet radio technology.

2. T16002I City College of New York Adm. Voice Equipment

Accomplishments to date:

- This effort began in January 1978. A single printed circuit board Adaptive Delta-Modulation (ADM) algorithm has been designed, built and laboratory tested.
- Comparison tests between the ADM and latest Magnavox CVSD chips have been conducted which showed ADM has a 40 dB useful dynamic range compared to about 20 dB for CVSD.
- One and two-dimensional video ADM's have been built and tested. Semi-custom LSI design for the 2-D video ADM is nearly complete.

FY79 Objectives:

- Construct three ADM PC boards for installation in ECI digital network voice terminals.
- Construction of a deliverable 2-D video ADM for use in packet radio tests and multimedia conferencing experiments.

3. T16102I Network Analysis Corp. Deployment Strategies

Accomplishments to date:

- The effort was initiated during the last quarter of FY78.
- NAC and CORADCOM have determined the set of packet radio capabilities to be included in the evaluation.

FY79 Objectives:

- To develop a strategy for the deployment of packet radio equipment in a typical Army setting with testbed scenarios to be provided by CORADCOM and The Signal School.



DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

1400 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22209



4 JAN 1978

MEMORANDUM FOR THE DIRECTOR, PROGRAM MANAGEMENT

SUBJECT: Request for an ARPA Order - Network Analysis Corporation

- REFERENCES:
- a. NAC Proposal 2671
 - b. NAC Letter dated 8 Dec 1977
 - c. Work Statement
 - d. Selected Source Justification
 - e. PM File Material

SUMMARY:

It is requested that an ARPA Order be issued for \$160,000 to the U.S. Army Electronics Command, Fort Monmouth, NJ to initiate a new contract with Network Analysis Corporation for a period of 6 months beginning on or before 1 April 1977 and ending 30 September 1977. This work is in support of the ARPA/Army Packet Radio Testbed program. These funds are provided as partial payment for a planned 8 month effort costing a total of \$204,277. The balance will be provided in FY79.

Only task 1 is being funded with this action. By letter amendment, NAC has restructured task 1 to cover the 8 month period. Tasks 2 and 3 are not being funded with this action, but it is understood that ECOM may elect to fund task 3 directly,

OBJECTIVES:

The objective of this effort is to develop a strategy for the deployment of packet radio equipment in a typical Army setting. Testbed scenarios will be provided by ECOM and the Signal School.

BACKGROUND AND TECHNICAL NEED:

A Memorandum of Understanding was jointly signed by ARPA and DARCOM to initiate a jointly funded testbed for the purpose of evaluating the packet radio technology in a practical Army context. Toward this end, numerous planning discussions have occurred and preparations are being made to transfer equipment from the SRI technical testbed and a selected Army location during FY79.

In order to prepare for this eventuality, it is essential to develop a methodology for the deployment of this equipment so that the testbed will most closely reflect the needs and requirements of an operational field Army.

For the technical testing in the San Francisco bay area, SRI has uniformly deployed a few unattended packet radio repeaters at convenient elevated locations to form a backbone net and maintains two minicomputer stations (for

Subject

reliability) at the SRI Building in Menlo Park. All user traffic is relayed via the backbone.

In an Army setting, it is highly likely that most packet radios will be assigned to individuals for use rather than left unattended on nearby mountaintops. In this mode of operation, each packet radio must serve both as a relay for enroute packets in the "backbone" and for packet to and from its local user. A typical height for these radios may be only a few feet instead of several tens or hundreds of feet. A typical range may therefore be a few thousand feet rather than ten or twenty miles. Considerations such as these suggest that the needed density of radios for the Army application may be considerably larger than would be the case with an optimum geographic placement. In particular, the relays may have to be colocated with the troops.

One or more unattended packet radios may, of course, be deployed in selected locations to provide added area coverage, lower end to end delay, higher throughput, or increased reliability/survivability.

Various scenarios have been suggested by ECOM and the Signal School for use of packet radios. These scenarios need to be further evaluated with respect to specific deployments of packet radios and stations. In particular, the ability of the packet radio system deployment to support the performance requirements of each scenario must be determined. Finally, methodological guidelines need to be developed for the use of packet radio equipment in the field.

This work will be carried out with the use of a packet radio network simulator developed by NAC during the initial phase of the packet radio program. Several minor additions or modifications to the simulator are necessary to incorporate the most recent changes. The simulator is available on the ARPANET and, with proper documentation and training, could be used directly by the Army. Task 3, if funded by ECOM would facilitate the transfer of this simulation capability from NAC to ECOM. ECOM and ECAC are currently considering the possibility of jointly funding task 3.

RELATED GOVERNMENT ACTIVITIES AND COORDINATING MECHANISMS:

There are no related activities in the government. This work will be monitored by ECOM directly.

ACCOMPLISHMENTS:

This is a new start. Under a previous contract through DSS-W, NAC designed

several key aspects of the packet radio system and developed the packet radio simulation system to aid in the system design.

PROPOSED EFFORT:

The contractor will develop a methodology for the deployment of packet radio equipment in an operational field Army setting and will evaluate the performance of such a system for several specific scenarios to be provided by ARPA. In particular, the contractor shall:

1. Develop an algorithm for flow assignment in local distribution networks. The algorithm determines multiple labels for repeaters, which maximize the throughput. The labels are a function of topology (including number of stations) and the traffic pattern. One criterion that will be used for hierarchical routing and uniform traffic pattern is a convex combination of the minimum number of hops and minimum number of interfering repeaters along the paths assigned.

2. Develop a topological design algorithm for a stand-alone packet radio system. Given locations of terminals and traffic requirements, transmission ranges for packet radio units, topographies and physical system constraints, determine the organization, location and deployment of stations and repeaters which satisfy traffic delay, connectivity, and survivability constraints with the fewest number of redundant packet radio units.

3. Develop algorithms for topological design of an area coverage system. In this case terminal and host locations are not known and these devices are assumed mobile within the area for which the system is designed. Two problems will be solved:

Low throughput system: connectivity (or reliability) constraint; the capacity problem is not solved.

High throughput system: requires incorporation of routing and capacity assignment.

4. Codify and integrate the solutions to subtasks 1, 2, and 3 into an overall methodology for packet radio systems.

5. Extend and integrate the packet radio reliability/survivability techniques previously developed by NAC with the system approach developed in subtask 4.

6. Modify routing procedures within Packet Radio Simulation Program as follows:

6.a Implement in the NAC Simulation Program those modifications to the channel access protocol for acceptance and acknowledgement of alternate routed packets.

6.b Implement a station procedure for handling these general alternate routed packets.

7. Based on discussions with ARPA and other organizations selected by ARPA, construct user profiles, requirements and a traffic data base for the specific test bed scenarios to be studied.

8. Extend the Simulation Program's traffic generation capabilities to incorporate the characteristics of users identified in subtask 7.

9. Apply the results of subtask 1-5 to the specific test bed scenarios investigated in subtask 7.

9.1 Determine feasible network organizations to maintain connectivity and meet user requirements. Determine potential numbers and locations of stations, repeaters and terminals.

9.2 Perform a capacity and traffic analysis to identify the levels of traffic that can be accommodated by the system configurations developed.

9.3 Perform sensitivity analyses with respect to critical system parameters and requirements. These sensitivity analyses will be conducted with respect to several scenarios constructed jointly with ARPA. Representative scenarios include: possible destruction of stations, elimination of sections of the network due to jamming, etc.

10. Investigate possible operational and maintenance issues such as control of user access to the network and packet radio unit replacement policies.

11. Identify, where appropriate, enhancements to the packet radio system which can lead to substantial performance improvement in system operation for the specific scenarios examined.

12a. Provide a briefing to ARPA describing the results of subtasks 7 and 9 within six months of start of work.

12b. Provide a written report to ARPA describing the results of the entire project within eight months of start of work.

13. Maintain packet radio simulator. Model anticipated changes to packet radio system devices, protocols, or other software. Incorporate changes in packet radio simulator.

RELEVANCE TO THE DoD/ARPA MISSION FUNCTIONS:

The use of packet radio by the field Army requires a methodology for its deployment. This work seeks such a deployment strategy and an analysis of it for several key operation scenarios.

TRANSFER PLAN:

This work is part of a joint program to transfer the packet radio technology to the Army.

FINANCIAL AND ADMINISTRATIVE
MANAGEMENT CONSIDERATIONS

Funding History: (\$000)

Joint Effort: (X) No () Yes
(If yes, show organization and
breakout below)

Short Title of Work	Prior Years	CURRENT			Outyears to Completion
		FY-1	FY 78	FY+1	
Deployment Strategies	0	0	160	100	0

Funding Source: Funds are available from:

Program Element Designator	Line Item Number	\$000	Contract Period Inclusive Dates		
			Months	From	To
AC	T16004	160,000	6	1 Apr 78	30 Sep 78

ARPA Agent Expenses:

(X) The above-cited funds do not include Agent technical expenses.

() The above-cited funds include Agent technical expenses in the
amount of \$ _____.

NSF Classification(s):

<u>Contractor</u>	<u>Type of Performer</u>	<u>Type of Research</u>	<u>Field of Science</u>	<u>State Code</u>
NAC	5	A	23	33

Work Statement and Cost Proposal

- () Not applicable
- () The original and one copy of each of the work statements and estimated costs prepared by the Program Manager are included as attachment ____ to this memo.
- (X) The work statement(s) and costs generally acceptable for contract negotiations are cited in the following technical and cost proposal(s) included as attachment c to this memo.

<u>Contractor</u>	<u>Proposal No. or Title</u>	<u>Date</u>	<u>Pages or Section No.</u>
NAC	Letter Proposal	8 Dec 77	attached

Also included as attachment e, for the PM office files, are: one copy of the contractor's letter forwarding the proposal, the technical proposal's title page, the pages containing the desired statement of work, the cost proposal's title page, and the pages containing the costs.

- () A copy of the work statement prepared by the Program Manager should be sent to the Agent.
- () The Agent has a current copy of the contractor's proposal.
- (X) The Agent does not have a current copy of the proposal. Request PM send the Agent the attached proposal as an attachment to the AO/Amendment.

Reporting Requirements:

Management Reports:

The PM office will determine frequency of Management Reports.

Technical Reports:

() Quarterly (X) Mid-term in this effort
() Semi-annually (X) Final () Special
Technical Reports upon completion of a significant task, test, event or symposium

Milestone Reports:

() Monthly

Continue Current Contract
Reports:

()

Other:

Security Classification Guide:

- (X) No security classification guide is required. Work is unclassified.
- () The technical scope of this effort precludes definition by a security classification guide at this time. A tentative security classification of _____ applies pending review and determination of the results of this research by this ARPA Project Office.
- () A classification guide is being prepared by _____;
(organization)
will be available by _____.
(date)
- () Two copies of the current security classification guide are attached.
- () Attached is a copy of the current security classification guide that was submitted to the agent on _____ by _____.
- () The Security Classification Guide submitted to the Agent as an attachment to AO _____ Amendment _____ applies to this Amendment.
- () Other:

Selected Source Justification:

- () Not required. This request is a continuation of effort and the Selected Source Justification attached to MRAO dated _____ has been examined and remains valid for this effort.
- () Not required. The work is being performed/directed by a government laboratory, or the justification will be provided by the Agent.
- () The Agent has selected the contractor or will select the contractor through the competitive process and the Agent's selections will be approved by the Program Manager prior to final commitment by the Agent.
- (X) See Attachment d ; Selected Source Justification. The original and one copy are attached and are undated.

Economic Analysis and Program Evaluation for Resource Management:

- (X) In keeping with the concepts of DoD Instruction No. 7041.3, dated October 3, 1972, subject: as above; alternatives were considered and the determination made that the proposal recommended herein best serves the interests of the Government.
- () See Attachment _____ for economic analysis and program evaluation for resource management.

Assessment of Environmental Consequences:

- (X) Based on an evaluation of the proposed research, it has been determined that an Environmental Impact Statement is not required.
- () See Attachment _____ for the Environmental Impact Statement.

Transfer of Title to Equipment to Non-Profit Educational or Research Institutions:

- (X) Not applicable
- () Title to equipment will be transferred to the non-profit institution upon acquisition (Director, ARPA memo, 31 Aug 73, subj: "Transfer of Title to Non-Profit Institutions.")
- () See attachment _____, for justification that title to equipment should be retained by the Government.

Agent Selection:

- () Not required. This request is a continuation of effort.
- (X) ECOM _____
(ARPA Agent)
has been selected because they have primary Army responsibility for the Army Packet Radio Testbed.

FOREIGN POLICY IMPLICATIONS

- (X) The proposed effort is not in conflict with DoD Directive 5100.62, dated August 19, 1969 Subj: "Clearance of Research Studies with Foreign Affairs Implications" or the OASD (ISA)/ARPA Memo of Understanding, dated January 26, 1973, Subj: "OASD (ISA)/ARPA Interface on Research with Foreign Affairs Implications".
- () This effort does have foreign affairs implications and ISA Clearance is included as attachment _____ to this memo.

Program Manager:

David C. Russell

694-4001

(Name)

(Phone)



David C. Russell, Colonel, USA
Director
Information Processing Techniques
Office

Attachments:

- a. NAC Proposal 2671
- b. NAC Letter dtd 8 Dec 1977
- c. Work Statement
- d. Selected Source Justification
- e. PM File Material

FOREIGN POLICY IMPLICATIONS

- (x) The proposed effort is not in conflict with DoD Directive 5100.62, dated August 19, 1969 Subj: "Clearance of Research Studies with Foreign Affairs Implications" or the OASD (ISA)/ARPA Memo of Understanding, dated January 26, 1973, Subj: "OASD (ISA)/ARPA Interface on Research with Foreign Affairs Implications".
- () This effort does have foreign affairs implications and ISA Clearance is included as attachment _____ to this memo.

Program Manager:

David C. Russell

694-4001

(Name)

(Phone)

SIGNED

David C. Russell, Colonel, USA
Director
Information Processing Techniques
Office

Attachments:

- a. NAC Proposal 2671
- b. NAC Letter dtd 8 Dec 1977
- c. Work Statement
- d. Selected Source Justification
- e. PM File Material

Coor:

Bill was

Judy gd

Prep: REK/3Jan78/hh/45922

pedd

SUMMARY OF PROPOSED TASKS AND COMPLETION SCHEDULE

1.1 SUPPORT OF EXPERIMENTAL TEST BED AND SYSTEM DESIGN

1. Develop an algorithm for flow assignment in local distribution networks. The algorithm determines multiple labels for repeaters, which maximize the throughput. The labels are a function of topology (including number of stations) and the traffic pattern. One criterion that will be used for hierarchical routing and uniform traffic pattern is a convex combination of the minimum number of hops and minimum number of interfering repeaters along the paths assigned.
2. Develop a topological design algorithm for a stand-alone packet radio system. Given locations of terminals and traffic requirements, transmission ranges for packet radio units, topographies and physical system constraints, determine the organization, location and deployment of stations and repeaters which satisfy traffic delay, connectivity, and survivability constraints with the fewest number of redundant packet radio units.
3. Develop algorithms for topological design of an area coverage system. In this case terminal and host locations are not known and these devices are assumed mobile within the area for which the system is designed. Two problems will be solved:

Low throughput system: connectivity (or reliability) constraint; the capacity problem is not solved.

High throughput system: Requires incorporation of routing and capacity assignment.
4. Codify and integrate the solutions to subtasks 1, 2, and 3 into an overall methodology for packet radio systems for local distribution area.

5. Extend and integrate the packet radio reliability/ survivability techniques previously developed by NAC with the system approach developed in subtask 4.
6. Modify routing procedures within Packet Radio Simulation Program as follows:
 - 6.a Implement in Simulation Program modifications to hop protocol for acceptance and acknowledgement of alternate routed packet independent of hierarchy.
 - 6.b Implement a station procedure for handling these general alternate routed packets.
7. Based on discussions with ARPA and other organizations selected by ARPA, construct user pro-files, requirements and a traffic data base for the specific test bed scenarios to be studied.
8. Extend the Simulation Program's traffic generation capabilities to incorporate the characteristics of users identified in subtask 7.
9. Apply the results of subtasks 1-5 to the specific test bed scenarios investigated in subtask 7.
 - 9.1 Determine feasible network organizations to maintain connectivity and meet user requirements. Determine potential numbers and locations of stations, repeaters and terminals.
 - 9.2. Perform a capacity and traffic analysis to identify the levels of traffic that can be accommodated by the system configurations developed.
 - 9.3 Perform sensitivity analyses with respect to critical system parameters and requirements. These sensitivity analyses will be conducted with respect to several scenarios constructed jointly with ARPA. Representative scenarios include: possible destruction of stations, elimination of sections of the network due to jamming, etc.

10. Investigate possible operational and maintenance issues such as control of user access to the network and packet radio unit replacement policies.
11. Identify, where appropriate, enhancements to the packet radio system which can lead to substantial performance improvement in system operation for the specific scenarios examined.
- 12a. Provide a briefing to ARPA describing the results of subtasks 7 and 9 within six months of start of work.
- 12b. Provide a written report to ARPA describing the results of the entire project within eight months of start of work.

TASK COMPLETION SCHEDULE

Task Number 1	MONTHS							
	1	2	3	4	5	6	7	8
1. Flow Assignment Algorithm		X						
2. Fixed Location Design		X						
3. Area Coverage Design			X					
4. Methodology Integration				X				
5. Reliability/Survivability				X				
6. Hierarchical routing			X					
7. User Profiles		X						
8. Traffic Generation			X					
9.1 Configuration Analysis				X				
9.2 Capacity and Traffic Analysis				X				
9.3 Sensitivity Analysis						X		
10. Operational Issues							X	
11. Enhancements							X	
12a. ARPA Briefing						X		
12b. Report								X

**DEFENSE ADVANCED RESEARCH PROJECTS AGENCY**

1400 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22209



MEMORANDUM FOR THE RECORD

SUBJECT: Selected Source Justification - Network Analysis Corporation

I have selected Network Analysis Corporation (NAC) to carry out this work.

Under previous contract to ARPA, NAC developed a packet radio simulator to aid in the design of packet radio networks. It is proposed to utilize this simulator with only minor update changes.

No other contractor has an equivalent capability at the present time. The tight time and funding constraints of the ARPA/Army testbed program preclude developing this capability at another contractor.

A handwritten signature in dark ink, reading "David C. Russell".

David C. Russell, Colonel, USA
Program Manager
Information Processing Techniques
Office

TECHNICAL PROPOSAL #2671

A PROPOSAL FOR
GROUND PACKET RADIO DATA AND VOICE SYSTEMS
ANALYSIS AND DESIGN

SUBMITTED TO
ADVANCED RESEARCH PROJECTS AGENCY
1400 Wilson Blvd.
Arlington, Va. 22212

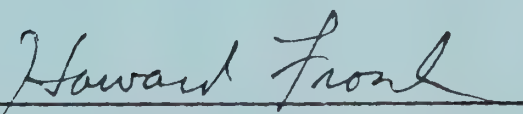
PROPOSED PERIOD OF PERFORMANCE
1 OCTOBER 1977 - 30 SEPTEMBER 1978

COST PLUS FIXED FEE: \$516,127

July 8, 1977

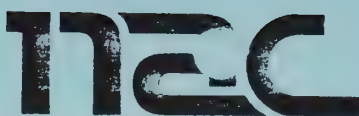
NETWORK ANALYSIS CORPORATION
130 STEAMBOAT ROAD
GREAT NECK, NEW YORK 11024

Principal Investigators
Dr. Howard Frank
Dr. Israel Gitman


Approved: Howard Frank, President

NETWORK ANALYSIS CORPORATION

130 Steamboat Road • Great Neck, New York 11024 • (516) 829-5900



December 8, 1977

Dr. Robert Kahn
Information Processing Techniques Office
Advanced Research Projects Agency
1400 Wilson Blvd.
Arlington, Va. 22209

Dear Mr. Kahn:

This letter relates to NAC's outstanding proposal "Ground Packet Radio Analysis and Design," NAC Proposal Number 2671, 8 July 1977. In Task 1 of that proposal, NAC proposed Support for the Experimental Packet Radio Test Bed and System Design. Conversations with ARPA have indicated that ARPA has a near term need to focus attention on several specific test bed scenarios involved with the potential deployment of packet radio systems in Europe. The object is to provide a creditable extrapolation of packet radio feasibility and performance to the specific deployment scenarios proposed by ARPA. Much of the work proposed in Task 1 is directly relevant to this current requirement. However, certain factors not contemplated in our original proposal should be investigated to complete the effort required to fully meet ARPA's needs. Consequently, with this letter we are proposing to modify Task 1 as indicated below. The proposed modifications entail no change in cost or fees.

The proposed modifications include deletion of several subtasks, renumbering of others, and the addition of a number of other subtasks. A revised Task Statement which incorporates the proposed modifications is enclosed. Also enclosed is a Task Completion Schedule for these Tasks.

Sincerely,

Howard Frank
President

HF:rlw
Attachment



NETWORK ANALYSIS CORPORATION

Beechwood, Old Tappan Road, Glen Cove, N. Y. 11542 / 516 671-9580

July 8, 1977

Dr. Robert Kahn
Deputy Director
Information Processing Techniques Office
Advanced Research Projects Agency
1400 Wilson Blvd.
Arlington, VA 22212

Dear Dr. Kahn:

Enclosed are five copies of our unsolicited proposal for Research in Ground Packet Radio Data and Voice Systems Analysis and Design. We are submitting this proposal for your consideration.

Sincerely,

Howard Frank
President

HF:sm
Enc.

SUMMARY OF PROPOSED TASKS AND COMPLETION SCHEDULE

1.1 SUPPORT OF EXPERIMENTAL TEST BED AND SYSTEM DESIGN

1. Develop an algorithm for flow assignment in local distribution networks. The algorithm determines multiple labels for repeaters, which maximize the throughput. The labels are a function of topology (including number of stations) and the traffic pattern. One criterion that will be used for hierarchical routing and uniform traffic pattern is a convex combination of the minimum number of hops and minimum number of interfering repeaters along the paths assigned.
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High throughput system: Requires incorporation of routing and capacity assignment.
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6. Modify routing procedures within Packet Radio Simulation Program as follows:
 - 6.a Implement in Simulation Program modifications to hop protocol for acceptance and acknowledgement of alternate routed packet independent of hierarchy.
 - 6.b Implement a station procedure for handling these general alternate routed packets.
7. Based on discussions with ARPA and other organizations selected by ARPA, construct user pro-files, requirements and a traffic data base for the specific test bed scenarios to be studied.
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 - 9.3 Perform sensitivity analyses with respect to critical system parameters and requirements. These sensitivity analyses will be conducted with respect to several scenarios constructed jointly with ARPA. Representative scenarios include: possible destruction of stations, elimination of sections of the network due to jamming, etc.

10. Investigate possible operational and maintenance issues such as control of user access to the network and packet radio unit replacement policies.
11. Identify, where appropriate, enhancements to the packet radio system which can lead to substantial performance improvement in system operation for the specific scenarios examined.
- 12a. Provide a briefing to ARPA describing the results of subtasks 7 and 9 within six months of start of work.
- 12b. Provide a written report to ARPA describing the results of the entire project within eight months of start of work.

TASK COMPLETION SCHEDULE

Task Number 1	MONTHS							
	1	2	3	4	5	6	7	8
1. Flow Assignment Algorithm		X						
2. Fixed Location Design		X						
3. Area Coverage Design			X					
4. Methodology Integration				X				
5. Reliability/Survivability				X				
6. Hierarchical routing			X					
7. User Profiles		X						
8. Traffic Generation			X					
9.1 Configuration Analysis				X				
9.2 Capacity and Traffic Analysis				X				
9.3 Sensitivity Analysis						X		
10. Operational Issues							X	
11. Enhancements							X	
12a. ARPA Briefing						X		
12b. Report								X

DEPARTMENT OF DEFENSE CONTRACT PRICING PROPOSAL (RESEARCH AND DEVELOPMENT)				Form Approved Budget Bureau No. 22-R0100	
This form is for use when (i) submission of cost or pricing data (see ASPR 3-807.3) is required and (ii) substitution for the DD Form 633 is authorized by the contracting officer.				PAGE NO.	NO. OF PAGES
NAME OF OFFEROR NETWORK ANALYSIS CORPORATION		SUPPLIES AND/OR SERVICES TO BE FURNISHED GROUND PACKET RADIO DATA AND VOICE SYSTEMS ANALYSIS AND DESIGN			
HOME OFFICE ADDRESS (Include ZIP Code) 130 Steamboat Road Great Neck, New York 11024					
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Great Neck, New York		TOTAL AMOUNT OF PROPOSAL \$ 516,127		GOVT SOLICITATION NO. -	
DETAIL DESCRIPTION OF COST ELEMENTS					
1. DIRECT MATERIAL (Itemize on Exhibit A)			EST COST (\$)	TOTAL EST COST ¹	REFER- ² ENCE
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER - (1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (At other than cost)					
TOTAL DIRECT MATERIAL				-	
2. MATERIAL OVERHEAD ³ (Rate % X \$ base =)					
3. DIRECT LABOR (Specify)		ESTIMATED HOURS	RATE/ HOUR	EST COST (\$)	
Senior Project Engineer		512	20.00	10,240	
Project Engineer		2050	16.40	33,620	
Senior Engineer		5990	10.75	64,392	
Engineer		3360	8.20	27,552	
Programmer		3875	5.85	22,669	
Aides		2050	4.85	9,943	
Provision for Raises				11,789	
TOTAL DIRECT LABOR				180,205	
4. LABOR OVERHEAD (Specify department or cost center) ³		O.H. RATE	X BASE =	EST COST (\$)	
		133%	180,205	239,673	
TOTAL LABOR OVERHEAD				239,673	
5. SPECIAL TESTING (Including field work at Government installations)				EST COST (\$)	
TOTAL SPECIAL TESTING				-	
6. SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A)					
-					
7. TRAVEL (If direct charge) (Give details on attached Schedule)				EST COST (\$)	
a. TRANSPORTATION				5588	
b. PER DIEM OR SUBSISTENCE				1470	
TOTAL TRAVEL				7,058	
8. CONSULTANTS (Identity - purpose - rate)				EST COST (\$)	
TOTAL CONSULTANTS				-	
9. OTHER DIRECT COSTS (Itemize on Exhibit A)				46,575	
10. TOTAL DIRECT COST AND OVERHEAD				473,511	
11. GENERAL AND ADMINISTRATIVE EXPENSE (Rate % of cost element Nos.) ³				-	
12. ROYALTIES ⁴				-	
13. TOTAL ESTIMATED COST					
14. FEE OR PROFIT				42,616	
15. TOTAL ESTIMATED COST AND FEE OR PROFIT				516,127	
This proposal is submitted for use in connection with and in response to (Describe RFP, etc.)					
Unsolicited Proposal					
and reflects our best estimates as of this date, in accordance with the instructions to offerors and the footnotes which follow.					
TYPED NAME AND TITLE Dr. Howard Frank, President			SIGNATURE 		
NAME OF FIRM NETWORK ANALYSIS CORPORATION				DATE OF SUBMISSION July 8, 1977	

EXHIBIT A - SUPPORTING SCHEDULE (*Specify. If more space is needed, use blank sheets*)

COST EL NO.	ITEM DESCRIPTION (See footnote 5)	EST COST (\$)
7a	6 round trips, New York - California, 10 round trip New York - Washington, DC, 2 round trips New York - Boston, 2 round trips New York - Dallas, 14 round trips, New York - Ft. Moinmouth	\$ 5,588
7b	42 days per diem at \$35/day	\$ 1,470
9	Computer and connect time (CDC, UNA TENEX, UCLA 360/91	37,000
9	Reproduction	9,575

1. HAVE THE DEPARTMENT OF DEFENSE, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, OR THE ATOMIC ENERGY COMMISSION PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☒ YES ☐ NO *If yes, identify below.*

NAME AND ADDRESS OF REVIEWING OFFICE (Include ZIP Code)

TELEPHONE NUMBER/EXTENSION

DCAA.
605 Stewart Avenue, Garden City, New York 11530

(516)PII-8000 Ext. 269

11. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☒ NO *If yes, identify on a separate page.*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☒ YES ☐ NO *If yes, identify:* ☐ ADVANCE PAYMENTS ☒ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT (or, do you have any independently financed (IR & D) projects) FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT? ☐ YES ☒ NO

☐ YES ☒ NO If yes, identify

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN ASPR, SECTION XV (See 3-807.2 (c) (2))?

☒ YES ☐ NO *If no, explain on a separate page.*

INSTRUCTIONS TO OFFERORS

1. The purpose of this form is to provide a standard format by which the offeror submits to the Government a summary of incurred and estimated cost (and attached supporting information) suitable for detailed review and analysis. Prior to the award of a contract resulting from this proposal the offeror shall, under the conditions stated in ASPR 3-807.3, be required to submit a Certificate of Current Cost or Pricing Data (see ASPR 3-807.3(e) and 3-807.4).

2. As part of the specific information required by this form, the offeror must submit with this form, and clearly identify as such, cost or pricing data (that is, data which is verifiable and factual and otherwise as defined in ASPR 3-807.3(e)). In addition, he must submit with this form any information reasonably required to explain the offeror's estimating process, including:

- a. the judgmental factors applied and the mathematical or other methods used in the estimate including those used in projecting from known data, and

b. the contingencies used by offeror in his proposed price.

3. When attachment of supporting cost or pricing data to this form is impracticable, the data will be specifically identified and described (with schedules as appropriate), and made available to the contracting officer or his representative upon request.

4. The format for the "Cost Elements" is not intended as rigid requirements. These may be presented in different format with the prior approval of the contracting officer if required for more effective and efficient presentation. In all other respects this form will be completed and submitted without change.

5. By submission of this proposal, offeror, if selected for negotiation, grants to the contracting officer, or his authorized representative, the right to examine, for the purpose of verifying the cost or pricing data submitted, those books, records, documents and other supporting data which will permit adequate evaluation of such cost or pricing data, along with the computations and projections used therein. This right may be exercised in connection with any negotiations prior to contract award.

FOOTNOTES

J Enter in this column those necessary and reasonable costs which in the judgment of the offeror will properly be incurred in the efficient performance of the contract. When any of the costs in this column have already been incurred (e.g., on a letter contract or change order), describe them on an attached supporting schedule. Identify all sales and transfers between your plants, divisions, or organizations under a common control, which are included at other than the lower of cost to the original transferor or current market price.

2 When space in addition to that available in Exhibit A is required, attach separate pages as necessary and identify in this "Reference" column the attachment in which information supporting the specific cost element may be found. No standard format is prescribed; however, the cost or pricing data must be accurate, complete and current, and the judgment factors used in projecting from the data to the estimates must be stated in sufficient detail to enable the contracting officer to evaluate the proposal. For example, provide the basis used for pricing materials such as by vendor quotations, shop estimates, or invoice prices; the reason for use of overhead rates which depart significantly from experienced rates (reduced volume, a planned major rearrangement, etc.); or justification for an increase in labor rates (anticipated wage and salary increases, etc.). Identify and explain any contingencies which are included in the proposed price, such as anticipated costs of rejects and defective work, or anticipated technical difficulties.

3 Indicate the rates used and provide an appropriate explanation. Where agreement has been reached with Government representatives on the use of forward pricing rates, describe the nature of the agreement. Provide the method of computation and application of your overhead expense, including cost breakdown and showing trends and budgetary data as necessary to provide a basis for evaluation of the reasonableness of proposed rates.

4 If the total royalty cost entered here is in excess of \$250 provide on a separate page (or on DD Form 783, Royalty Report) the following information on each separate item of royalty or license fee: name and address of licensor; date of license agreement; patent numbers, patent application serial numbers, or other basis on which the royalty is payable; brief description, including any part or model numbers of each contract item or component on which the royalty is payable; percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.

5 Provide a list of principal items within each category indicating known or anticipated source, quantity, unit price, competition obtained, and basis of establishing source and reasonableness of cost.

COST DISTRIBUTION BY TASK

<u>CATEGORY</u>	<u>AMOUNT</u>
1. Experimental Tests and System Design, Tasks 1.1 - 1.12,	\$ 165,558
Experimental Tests and System Design, Optional Task 1.13	\$ 38,719
2. Voice Traffic and Protocols	\$ 160,654
3. Optional Documentation and Transfer of Simulator	<u>\$ 151,196</u>
Total	516,127

*Note: Costs assume no cost access to ARPA Supplied Time-sharing Services

NETWORK ANALYSIS CORPORATION



130 Steamboat Road • Great Neck, New York 11024 • (516) 829-5900

April 15, 1980

Dr. Robert Kahn
ARPA
1400 Wilson Boulevard
Arlington, VA 22209

Dear Mr. Kahn:

I am writing to tell you about a major event in NAC's corporate development which will significantly expand our ability to serve your organization. A few weeks ago, NAC and Continental Telephone Corporation signed a letter of intent which will lead to our becoming a member of the Continental System. These are some of the factors which motivated us to take this step:

- Continental, the third largest non-Bell telephone system in the country, has embarked on an aggressive and carefully planned strategy aimed at positioning the company as one of the nation's foremost suppliers of integrated systems and services for organizations seeking to apply modern telecommunications techniques and equipment to their operations. Fueling this strategy are ongoing sales and revenues of more than a billion dollars a year and profits in excess of \$100 million. Continental has already expanded beyond its traditional telephone operations into areas such as interconnect telephone equipment, CATV operations, satellite communications and other related fields.
- NAC, on a much smaller scale, has conceived a parallel business plan which is intended to greatly enlarge our ongoing consulting activities in the field of network architecture and design and to extend these activities both horizontally and vertically into such areas as turnkey systems, communications software, international consulting and specialized devices for local networks. Our plan, though aggressive, has been limited in scope and pace, until now, by the size of our company.
- Continental and NAC have agreed to a relationship under which the respective strengths of our two companies will be applied to the achievement of our common and compatible goals.

Underlying this plan are certain basic operating principles which I think will be of interest to you. They are:

- NAC will retain and strengthen its position as an independent consulting organization. We will continue to provide our clients with unbiased judgments on appropriate network strategies and on the selection of the most suitable vendors of systems and equipment. This principal was established as a sine qua non in our earliest discussions with Continental, whose executives fully understand that our continued success as a business depends upon it. As a matter of fact, we've agreed that NAC's work on Continental's internal requirements will be carried out in a conventional consultant-client mode in order to maintain the arm's length relationship needed to assure our independence.

Washington Operations: Vienna, Virginia

THE WHITE HOUSE
WASHINGTON

April 1, 1980

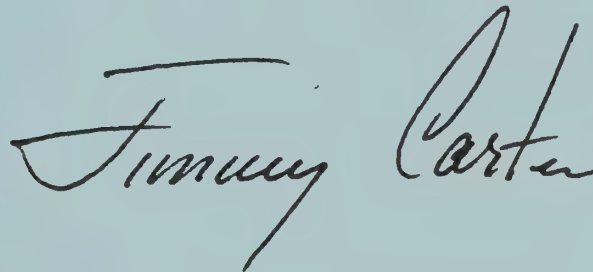
To Howard Frank

In your capacity as a member of the Advisory Committee on Information Network Structure and Functions for the Executive Office of the President you have donated your time and talents to create a coordinated, long-range plan for development of an electronic network.

I want to take this opportunity to thank you for serving with this Committee and to commend you for your willingness to accept the challenge of assisting, without personal benefit, in the effort to evolve a more efficient federal government system.

Best wishes.

Sincerely,

A handwritten signature in dark ink, reading "Jimmy Carter". The signature is written in a cursive style with a large, sweeping "J" and a long, horizontal stroke for the "C".

Dr. Howard Frank
President
Network Analysis Corporation
130 Steamboat Road
Great Neck, New York 11024

- NAC will never alter its policy with respect to the confidentiality of client projects. This policy, and the rigorous internal procedures which support it, allowed us to work on both AT&T's ACS project and Xerox's XTEN project simultaneously. Not only were these activities totally isolated from each other, but most of our own staff members were unaware of XTEN's existence until it was formally disclosed by Xerox a year after we started work on the project.
- The first order of business for me and for NAC's entire staff will always be to serve NAC's clients. This is not merely a pious stance -- it is a very practical consideration. Here's why: The agreement contained in the letter of intent calls for NAC's manager/stockholders to retain their shares in the company until some time in the future when they have the option to sell these shares to Continental at a multiple of NAC's earnings-per-share at that future time. Thus, we are highly motivated to promote NAC's individual growth and profitability over the years to come. Clearly this can only be achieved if we devote our energies to fostering the source of this growth and profitability, and we defined that source long ago -- satisfied clients!

From your perspective, the sum of all these elements is, I believe, fairly evident. NAC's ability to serve you has not been diminished in any respect, and, in many ways, has been significantly enhanced. We are now in a much stronger position to expand our resources, human and otherwise. We can accelerate the development of new and extended services in order to encompass a greater range of your requirements. And, through our involvement in Continental's corporate development, we can help translate industry's needs for modern, cost-effective telecommunications into marketplace realities.

I most genuinely welcome any comments or questions you may have on the subjects covered in this letter and would be most grateful if you communicated them to me directly.

Sincerely,



Howard Frank
President

HF:ks
Enclosure

P.S. I hope you will forgive the touch of pride which prompted me to enclose a copy of a letter I recently received from President Carter.

Produced at the National Archives

NETWORK ANALYSIS CORPORATION

130 Steamboat Road • Great Neck, New York 11024 • (516) 829-5900

NAC

403 549

October 18, 1979

Commander
USA CORADCOM
Fort Monmouth, New Jersey 07703

Attention: DRDCO-COM-RF-4

Gentlemen:

In accordance with Contract Number DAAK80-79-C-0763, this letter constitutes our third quarterly technical and management report. This constitutes deliverables A003 and A004 for the time period July 1, 1979 through September 30, 1979.

1. TECHNICAL PLAN

The studies being performed by Network Analysis Corporation are intended to assess the potential utilization of Packet Radio (PR) technology for the military environment. The primary emphasis is on the quantitative evaluation of network performance using throughput, delay, buffer utilization, and survivability as performance criteria. The NAC activities consist of the following three tasks:

- Task 1. Packet Radio Simulation Model Update, Refinement, and Validation.
- Task 2. Military Scenario Modeling.
- Task 3. Experimental Network Design.

Task 1 involves the modification of NAC's existing PR simulation program to more accurately model the DARPA prototype PR network and validate the simulator performance versus that of the test bed.

In Task 2 NAC is developing a computerized data base representing the military scenario defined by the DARPA designated organization, MITRE. Also as part of Task 2, NAC is interfacing the PR simulation program with the data base.

Then in Task 3 NAC is designing an experimental PR network for use in the military environment to handle the traffic requirements defined in the data base. The network design includes selection of dedicated repeater sites (if necessary), data rates, subnetworks, and message routes. After the experimental network has been designed, the performance will be evaluated via simulation; sensitivity analyses will also be done to evaluate the robustness of the performance. The algorithmic design in Task 3 is being done in conjunction with Polytechnic Institute of New York (P.I.N.Y).

DRDCO-COM-RF-4

October 18, 1979

Page 2

2. ACCOMPLISHMENTS

The major technical accomplishments by Task during the quarter consist of:

Task 1: (Simulation)

- Implementation of an enhanced statistics gathering capability for measuring one way and round trip delays of packets and messages.
- Implementation of capability to simulate the integral terminal relay capability.
- Implementation of an enhanced terminal queue management feature to simulate multiple TCP connections.
- Implementation of capability to simulate transmission Local Repeater on Packets (LROP's).

Task 2: (Military Model)

- Modifications of Scenario Generator to generate traffic profile for a gateway configuration.
- Implementation of capability in Scenario Generator to assign shortest path routes.

Task 3: (Design and Analysis)

- Formulation of procedure to choose shortest path routes to alleviate congestion.
- Completion of analytic development to estimate (and bound) throughput tandem PR networks can support.

3. PROBLEMS ENCOUNTERED

None.

4. FISCAL STATUS

Amount Expended (through September 30, 1979)	\$180,160
Amount Available to Complete Work	23,352
Amount Required to Complete Work	23,352

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October 18, 1979
Page 3

5. FUTURE PLANS

Draft Final Report will be delivered in late October.

6. ACTION BY CORADCOM

None.

Respectfully submitted,

David Walters

David Walters
Director
Communications Systems Analysis

DW/cs

cc: M. Bereschinsky (CORADCOM)
L. Druffel (DARPA) ✓

207

<- type 130
 (msg. # 130, 558 chars)
 Date: 10 MAY 1978 1208-PDT
 From: STUBBS
 Subject: AO 3549 - NETWORK ANALYSIS CORP
 To: CENCOMS-F4, KAHN, STUBBS

BUD-

The revised NAC proposal #2671-R1 (Task #1), dated 3 May 1978, is acceptable to DARPA/IPTO for the research requested under ARPA Order 3549, dated 16 January 1978.
 The total estimated cost for this effort, as revised, is not changed by this substitution.

Eugene W. Stubbs
 Program Management Officer

.....
 Will that do it?
 Gene

SUSPENSE:
 FROM: NA
 DATE: 8 May 78

FILE
AO 3549

☒ Action	Hilda
☒ Info	Judy Dewey
☒ Circulate	June
☒ File	Judy Guerny-Lusby
☒ Destroy	Juanita
☒ Forward	

☒ Russell	
☒ Kahn	
☒ Carlson	
☒ Carlstrom	
☒ Cerf	
☒ Hollister	
☒ Adams	
☒ Dietzler	

me
NAC
NA
Order -

known
no action
needed

NETWORK ANALYSIS CORPORATION

130 Steamboat Road • Great Neck, New York 11024 • (516) 829-5900



May 3, 1978

Dr. Robert Kahn
Information Processing Techniques Office
Advanced Research Projects Agency
1400 Wilson Blvd.
Arlington, VA 22209

Dear Dr. Kahn:

This letter relates to NAC's outstanding proposal "Ground Packet Radio Analysis and Design," NAC Proposal Number 2671; 8 July 1977. With this letter we are proposing to revise Task 1 of that proposal in order to relate it to specific ARPA needs that have arisen during the past year. The attached Statement of Work, Tasks 1-3, represent our proposed revision of the original Task 1 of the 8 July Proposal. Also included is a completed Form DD-633 for these tasks. Also, included in the attached Statement of Work is Optional Task 4 which corresponds to Optional Task 3 of the original proposal. We will provide a price quotation for this task upon request.

Sincerely,

Howard Frank
President

HF:sm
Enc.

cc: Commander
U.S. Army-Comm. Research & Dev. Command
Ft. Monmouth, NJ 07703
ATTN: DRDCO-COM-RF-4

DEPARTMENT OF DEFENSE CONTRACT PRICING PROPOSAL (RESEARCH AND DEVELOPMENT)				Form Approved Budget Bureau No. 22-R100	
This form is for use when (i) submission of cost or pricing data (see ASPR 3-807.3) is required and (ii) substitution for the DD Form 633 is authorized by the contracting officer.				PAGE NO. 1	NO. OF PAGES 1
NAME OF OFFEROR NETWORK ANALYSIS CORPORATION		SUPPLIES AND/OR SERVICES TO BE FURNISHED Ground Packet Radio Analysis and Design NAC Proposal #2671-R1 (Task 1)			
HOME OFFICE ADDRESS (Include ZIP Code) 130 Steamboat Road Great Neck, New York 11024					
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Same		TOTAL AMOUNT OF PROPOSAL \$ 204,277.00		GOVT SOLICITATION NO.	
DETAIL DESCRIPTION OF COST ELEMENTS					
1. DIRECT MATERIAL (Itemize on Exhibit A)			EST COST (\$)	TOTAL EST COST ¹	REFER- ² ENCE
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER - (1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (At other than cost)					
TOTAL DIRECT MATERIAL					
2. MATERIAL OVERHEAD ³ (Rate % X \$ base =)					
3. DIRECT LABOR (Specify)		ESTIMATED HOURS	RATE/ HOUR	EST COST (\$)	
Senior Project Engineer		212	\$20.00	\$4240.00	
Project Engineer		900	16.40	14760.00	
Senior Engineer		1875	10.75	20156.00	
Engineer		2240	8.20	18368.00	
Programmer		1000	5.85	5850.00	
Aides		800	4.85	3880.00	
Provision for Raises				4708.00	
TOTAL DIRECT LABOR				\$71962.00	
4. LABOR OVERHEAD (Specify department or cost center) ³		O.H. RATE	X BASE =	EST COST (\$)	
		133%	71962.00	95,710	
TOTAL LABOR OVERHEAD				95710.00	
5. SPECIAL TESTING (Including field work at Government installations)			EST COST (\$)		
TOTAL SPECIAL TESTING					
6. SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A)					
7. TRAVEL (If direct charge) (Give details on attached Schedule)			EST COST (\$)		
a. TRANSPORTATION			\$2478.00		
b. PER DIEM OR SUBSISTENCE			560.00		
TOTAL TRAVEL				3038.00	
8. CONSULTANTS (Identify - purpose - rate)			EST COST (\$)		
TOTAL CONSULTANTS					
9. OTHER DIRECT COSTS (Itemize on Exhibit A)				17900.00	
TOTAL DIRECT COST AND OVERHEAD				189610.00	
11. GENERAL AND ADMINISTRATIVE EXPENSE (Rate % of cost element Nos.					
12. ROYALTIES ⁴					
TOTAL ESTIMATED COST					
14. FEE OR PROFIT				15667.00	
TOTAL ESTIMATED COST AND FEE OR PROFIT				204277.00	
This proposal is submitted for use in connection with and in response to (Describe RFP, etc.)					
and reflects our best estimates as of this date, in accordance with the instructions to offerors and the footnotes which follow.					
TYPED NAME AND TITLE Dr. Howard Frank, President			SIGNATURE 		
NAME OF FIRM NETWORK ANALYSIS CORPORATION			DATE OF SUBMISSION 5/3/78		

EXHIBIT A - SUPPORTING SCHEDULE (Specify. If more space is needed, use blank sheets)

COST EL NO.	ITEM DESCRIPTION (See footnote 5)	EST COST (\$)
7a.	3 round trips New York - California; 4 round trips New York - Washington, D.C.; 1 round trip New York - Boston; 1 round trip New York - Dallas; 3 round trips New York - Ft. Monmouth	\$ 2,478.00
7b.	16 days per diem at \$35/day	560.00
9.	Computer and connect time (CDC, UNA Tenex, UCLA 360/91) assuming no cost access to ARPA supplied timesharing services	13,000.00
9.	Reproduction	3,700.00
9.	CAS 414, cost of money, .01669 X \$71962.00 Base-D/L	1,200.00

I. HAVE THE DEPARTMENT OF DEFENSE, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, OR THE ATOMIC ENERGY COMMISSION PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☒ YES ☐ NO If yes, identify below.

NAME AND ADDRESS OF REVIEWING OFFICE (Include ZIP Code) Mr. Jack Shaw
DCAA 605 Stewart Avenue, Garden City, New York 11530

TELEPHONE NUMBER/EXTENSION
(516) PII-8000 Ext. 269

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☒ NO If yes, identify on a separate page.

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☒ YES ☐ NO if yes, identify: ☐ ADVANCE PAYMENTS ☒ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT (or, do you have any independently financed (IR & D) projects) FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☒ NO If yes, identify

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN ASPR, SECTION XV (See 3-807.2 (c) (2))?

☒ YES ☐ NO If no, explain on a separate page.

INSTRUCTIONS TO OFFERORS

1. The purpose of this form is to provide a standard format by which the offeror submits to the Government a summary of incurred and estimated cost (and attached supporting information) suitable for detailed review and analysis. Prior to the award of a contract resulting from this proposal the offeror shall, under the conditions stated in ASPR 3-807.3, be required to submit a Certificate of Current Cost or Pricing Data (see ASPR 3-807.3(e) and 3-807.4).

2. As part of the specific information required by this form, the offeror must submit with this form, and clearly identify as such, cost or pricing data (that is, data which is verifiable and factual and otherwise as defined in ASPR 3-807.3(e)). In addition, he must submit with this form any information reasonably required to explain the offeror's estimating process, including:

- the judgmental factors applied and the mathematical or other methods used in the estimate including those used in projecting from known data, and
- the contingencies used by offeror in his proposed price.

3. When attachment of supporting cost or pricing data to this form is impracticable, the data will be specifically identified and described (with schedules as appropriate), and made available to the contracting officer or his representative upon request.

4. The format for the "Cost Elements" is not intended as rigid requirements. These may be presented in different format with the prior approval of the contracting officer if required for more effective and efficient presentation. In all other respects this form will be completed and submitted without change.

5. By submission of this proposal, offeror, if selected for negotiation, grants to the contracting officer, or his authorized representative, the right to examine, for the purpose of verifying the cost or pricing data submitted, those books, records, documents and other supporting data which will permit adequate evaluation of such cost or pricing data, along with the computations and projections used therein. This right may be exercised in connection with any negotiations prior to contract award.

FOOTNOTES

1 Enter in this column those necessary and reasonable costs which in the judgment of the offeror will properly be incurred in the efficient performance of the contract. When any of the costs in this column have already been incurred (e.g., on a letter contract or change order), describe them on an attached supporting schedule. Identify all sales and transfers between your plants, divisions, or organizations under a common control, which are included at other than the lower of cost to the original transferee or current market price.

2 When space in addition to that available in Exhibit A is required, attach separate pages as necessary and identify in this "Reference" column the attachment in which information supporting the specific cost element may be found. No standard format is prescribed; however, the cost or pricing data must be accurate, complete and current, and the judgment factors used in projecting from the data to the estimates must be stated in sufficient detail to enable the contracting officer to evaluate the proposal. For example, provide the basis used for pricing materials such as by vendor quotations, shop estimates, or invoice prices; the reason for use of overhead rates which depart significantly from experienced rates (reduced volume, a planned major rearrangement, etc.); or justification for an increase in labor rates (anticipated wage and salary increases, etc.). Identify and explain any contingencies which are included in the proposed price, such as anticipated costs of rejects and defective work, or anticipated technical difficulties.

3 Indicate the rates used and provide an appropriate explanation. Where agreement has been reached with Government representatives on the use of forward pricing rates, describe the nature of the agreement. Provide the method of computation and application of your overhead expense, including cost breakdown and showing trends and budgetary data as necessary to provide a basis for evaluation of the reasonableness of proposed rates.

4 If the total royalty cost entered here is in excess of \$250 provide on a separate page (or on DD Form 783, Royalty Report) the following information on each separate item of royalty or license fee: name and address of licensor; date of license agreement; patent numbers, patent application serial numbers, or other basis on which the royalty is payable; brief description, including any part or model numbers of each contract item or component on which the royalty is payable; percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.

5 Provide a list of principal items within each category indicating known or anticipated source, quantity, unit price, competition obtained, and basis of establishing source and reasonableness of cost.

STATEMENT OF WORK

Task 1 - Model Update, Refinement, and Validation

A. The existing NAC model PRSIM will be updated and refined to provide a valid and realistic model of current/future PRN. The PRSIM model will be updated and refined to include:

1. Integral relay capability (terminals may act as repeaters for packets already in the network)

2. Packet routing/alternate routing

- (A) Implement in PRSIM modifications to hop protocol for direct point-to-point routing, and alternate routing of information, control, and acknowledgement packets. Those mechanisms used to implement the routing and alternate routing in the model PRSIM will be accurate representations of those used in the actual PRN. The hierarchical routing will also be retained in the model, and be used optionally in the simulation.

- (B) Implement in PRSIM a procedure for handling and assigning point-to-point routes, and alternate routes by good neighbor tables, and local ROP's.

3. Enhancement of repeater/terminal models

- (A) Modify repeater/terminal model to account for preamble detection.

- (B) Modify repeater/terminal model to account for non-zero time carrier sense delay (receive after receive, receive after transmit) with typical values taken from PR equipment.

- (C) Modify repeater/terminal model to include accurate representation of both TCP and SPP ETE protocol, including time-outs, retransmit tries, buffering and windowing.

- (D) Modify repeater/terminal model to allow mobile communication while transmitting/receiving packets. (The terminals may be installed in helicopters, planes or other mobile units). To aid packet routing from mobile terminals, TOP's and DROP's will be accurately represented in the model.

- (E) Expand the set of channel access algorithms to include the modified ALOHA scheme.

B. The model PRSIM will also be validated to the maximum extent feasible by comparison to the San Francisco Bay area testbed. To provide this validation, the model PRSIM will be configured to represent specific scenarios set up in the Bay area testbed, and the values obtained by the simulation will be compared with values obtained from measured performance data. ARPA, or ARPA designated organization will supply the specific scenarios(s) to be used and the measured test results. NAC will make a reasonable effort to explain any and all discrepancies between simulated and measured data, and the PRSIM model will be modified as appropriate.

Task 2 -- Military Scenario to be used with model

A. Based on discussions with ARPA, and other organizations selected by ARPA, construct user profiles, requirements, and a traffic data base for the specific scenarios selected. The input user data base will include but not be limited to:

1. Geographic locations (X,Y,Z coordinates) of military units (real or fictitious).
2. An accurate digitized terrain map on which units operate.
3. A digitized terrain and propagation connectivity description for all units operating on the terrain map above.
4. A realistic traffic profile (user message description).
5. A description of the mobility of military units.
6. A description of the channel error rate.

B. The model PRSIM will be modified to accept the input user parameters as described above. Make modifications so that changes to input data base can be made with minimum impact on PRSIM, and with minimum effort to the person using the model.

C. Demonstrate that the model PRSIM with the input data base is fully operational and debugged. The input user data may be real or artificially constructed.

Task 3 --Experimental Network Design

A. The design model will be used with the data base collected under Task 2, to design a military packet radio network for selected

scenarios. Given the locations, traffic patterns and statistics, and connectivity of units (military terminals), and the desired throughput, maximum ETE delay, and survivability requirements, a design model will be developed to determine the following network parameters:

1. Network Topology -- The number of nets or subnets required including the number of stations and locations.
2. Information flow -- To determine information flow between terminals/repeaters in the network.
3. Capacity -- The required transmission bandwidth of terminal/repeaters -- to include a margin for future growth.
4. Requirements for additional hardware (if required, e.g., relay or higher power) to either extend range or provide additional capacity in areas of high traffic density, or to provide additional survivability.

B. The design model will be used to design a packet radio network for selected military scenarios. The network designs will meet the network requirements of throughput, maximum ETE delay, and survivability, and reflect the user requirements of the user data base as in Task 2.A. The design will be constructed so that constraints imposed on items 1 through 4 above may be used, and network design will then provide solution based on those constraints.

C. A sensitivity analysis shall be performed with respect to all critical system parameters and requirements in the design above. Sensitivity analysis shall include variations in connectivity, traffic generation rates, capacity, and survivability requirements.

Optional Task 4 -- Model Transfer to the ARMY, and Preparation of user documentation

A. The model PRSIM, will be modified to be fully operational and debugged on a selected computer system.

B. Specific PRSIM structural modifications and documentations will be as outlined below.

1. Create User Documentation.

Develop User's Guide including:

- Input and output formats and options

- Scenarios
 - Methodology for use
2. Remove outdated features
 - Old initialization procedure
 - Old terminal search protocol
 3. Reduce dependency on CDC-6600 by removing COMPASS routines and non-standard FORTRAN usage.
 4. Restructure critical section of code
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 - Interrelationship of events
 - Relationship between programs and events
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DELIVERABLE ITEMS -- For Tasks 1, 2, and 3.

A. Provide a briefing to ARPA and CORADCOM describing the results of all tasks within six months of start of work.

B. Provide a final written report to ARPA/CORADCOM describing the results of entire tasks 1 through 3 within eight months of start of work. The report will include as a minimum:

1. From Task 1, NAC will provide the comparisons of simulation results to the measured test data. NAC will update Packet Radio Temporary Note 200 to include additional parameters and formats resulting from the simulation enhancement.

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3. Also from Task 2, NAC will provide a verification that the model can accept the military user data base as inputs, operate on those inputs, and correctly perform the design.

4. From Task 3, NAC will provide the results of the packet radio network design as applied to the specified military scenarios. The network design results will include the network topology, maximum simulated ETE delay, information flow, capacity and additional hardware type (stations or repeater/terminals) and locations. The statistical outputs of the model PRSIM will also be provided.

5. From Task 3, NAC will interpret the results of the network designs for selected scenarios in (4) above. NAC will make an effort to explain any short comings or inconsistencies in the network designs.

6. From Task 3, NAC will provide explanations of the network design approaches used in the design of the military packet radio network. Limitations, potential short--comings that may exist in the network design algorithm will be explained to the maximum extent feasible.

7. From Task 3, NAC will provide discussions and results of the sensitivity analyses for each of the network designs.

C. Brief weekly progress reports for each task will be submitted via the ARPANET. A monthly report, via the ARPANET will also be submitted documenting progress and problem areas.

D. NAC shall prepare quarterly R&D Status Reports, a mid-term Technical and a Final Report. These reports are to be prepared and submitted IAW the memorandum of 1 July 1976, Subject: "Revised ARPA Order General Requirements."

E. If the optional task 4 is funded, NAC will complete the documentation and PRSIM transfer within six months of start of work on Task 4, but not earlier than twelve months from the start of this contract.

NETWORK ANALYSIS CORPORATION

130 Steamboat Road • Great Neck, New York 11024 • (516) 829-5900



May 3, 1978

**Dr. Robert Kahn
Information Processing Techniques Office
Advanced Research Projects Agency
1400 Wilson Blvd.
Arlington, VA 22209**

Dear Dr. Kahn:

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Sincerely,

A handwritten signature in dark ink, appearing to read 'Howard Frank', written in a cursive style.

**Howard Frank
President**

**HF:sm
Enc.**

**cc: Commander
U.S. Army-Comm. Research & Dev. Command
Ft. Monmouth, NJ 07703
ATTN: DRDCO-COM-RF-4**

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C. A sensitivity analysis shall be performed with respect to all critical system parameters and requirements in the design above. Sensitivity analysis shall include variations in connectivity, traffic generation rates, capacity, and survivability requirements.

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HOME OFFICE ADDRESS (Include ZIP Code) 130 Steamboat Road Great Neck, New York 11024					
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Same		TOTAL AMOUNT OF PROPOSAL \$ 204,277.00	GOVT SOLICITATION NO.		
DETAIL DESCRIPTION OF COST ELEMENTS					
1. DIRECT MATERIAL (Itemize on Exhibit A)			EST COST (\$)	TOTAL EST COST ¹	REFER- ² ENCE
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER - (1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (At other than cost)					
TOTAL DIRECT MATERIAL					
2. MATERIAL OVERHEAD ³ (Rate % X \$ base =)					
3. DIRECT LABOR (Specify)		ESTIMATED HOURS	RATE/ HOUR	EST COST (\$)	
Senior Project Engineer		212	\$20.00	\$4240.00	
Project Engineer		900	16.40	14760.00	
Senior Engineer		1875	10.75	20156.00	
Engineer		2240	8.20	18368.00	
Programmer		1000	5.85	5850.00	
Aides		800	4.85	3880.00	
Provision for Raises				4708.00	
TOTAL DIRECT LABOR				71962.00	
4. LABOR OVERHEAD (Specify department or cost center) ³		O.H. RATE	X BASE =	EST COST (\$)	
		133%	71962.00	95,710	
TOTAL LABOR OVERHEAD				95710.00	
5. SPECIAL TESTING (Including field work at Government Installations)			EST COST (\$)		
TOTAL SPECIAL TESTING					
6. SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A)					
7. TRAVEL (If direct charge) (Give details on attached Schedule)			EST COST (\$)		
a. TRANSPORTATION			\$2478.00		
b. PER DIEM OR SUBSISTENCE			560.00		
TOTAL TRAVEL				3038.00	
8. CONSULTANTS (Identify - purpose - rate)			EST COST (\$)		
TOTAL CONSULTANTS					
9. OTHER DIRECT COSTS (Itemize on Exhibit A)				17900.00	
TOTAL DIRECT COST AND OVERHEAD				188610.00	
11. GENERAL AND ADMINISTRATIVE EXPENSE (Rate % of cost element Nos.)					
12. ROYALTIES ⁴					
TOTAL ESTIMATED COST					
14. FEE OR PROFIT				15667.00	
TOTAL ESTIMATED COST AND FEE OR PROFIT				204277.00	
This proposal is submitted for use in connection with and in response to (Describe RFP, etc.)					
and reflects our best estimates as of this date, in accordance with the instructions to offerors and the footnotes which follow.					
TYPED NAME AND TITLE Dr. Howard Frank, President			SIGNATURE 		
NAME OF FIRM NETWORK ANALYSIS CORPORATION				DATE OF SUBMISSION 5/3/78	

1. HAVE THE DEPARTMENT OF DEFENSE, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, OR THE ATOMIC ENERGY COMMISSION PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☒ YES ☐ NO If yes, identify below.

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☒ NO *If yes, identify on a separate page.*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☒ YES ☐ NO if yes, identify: ☐ ADVANCE PAYMENTS ☒ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT (or, do you have any independently financed (IR & D) projects) FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT? ☐ YES ☒ NO If yes, identify

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN ASPR, SECTION XV (See 3-807.2 (c) (2))?

☒ YES ☐ NO If no, explain on a separate page.

1. The purpose of this form is to provide a standard format by which the offeror submits to the Government a summary of incurred and estimated cost (and attached supporting information) suitable for detailed review and analysis. Prior to the award of a contract resulting from this proposal the offeror shall, under the conditions stated in ASPR 3-807.3, be required to submit a Certificate of Current Cost or Pricing Data (see ASPR 3-807.3(e) and 3-807.4).

2. As part of the specific information required by this form, the offeror must submit with this form, and clearly identify as such, cost or pricing data (that is, data which is verifiable and factual and otherwise as defined in ASPR 3-807.3(e)). In addition, he must submit with this form any information reasonably required to explain the offeror's estimating process, including:

- a. the judgmental factors applied and the mathematical or other methods used in the estimate including those used in projecting from known data, and
- b. the contingencies used by offeror in his proposed price.

3. When attachment of supporting cost or pricing data to this form is impracticable, the data will be specifically identified and described (with schedules as appropriate), and made available to the contracting officer or his representative upon request.

48 The format for the "Cost Elements" is not intended as rigid requirements. These may be presented in different format with the prior approval of the contracting officer if required for more effective and efficient presentation. In all other respects this form will be completed and submitted without change.

5. By submission of this proposal, offeror, if selected for negotiation, grants to the contracting officer, or his authorized representative, the right to examine, for the purpose of verifying the cost or pricing data submitted, those books, records, documents and other supporting data which will permit adequate evaluation of such cost or pricing data, along with the computations and projections used therein. This right may be exercised in connection with any negotiations prior to contract award.

J. Enter in this column those necessary and reasonable costs which in the judgment of the offeror will properly be incurred in the efficient performance of the contract. When any of the costs in this column have already been incurred (e.g., on a letter contract or change order), describe them on an attached supporting schedule. Identify all sales and transfers between your plants, divisions, or organizations under a common control, which are included at other than the lower of cost to the original transferor or current market price.

2 When space in addition to that available in Exhibit A is required, attach separate pages as necessary and identify in this "Reference" column the attachment in which information supporting the specific cost element may be found. No standard format is prescribed; however, the cost or pricing data must be accurate, complete and current, and the judgment factors used in projecting from the data to the estimates must be stated in sufficient detail to enable the contracting officer to evaluate the proposal. For example, provide the basis used for pricing materials such as by vendor quotations, shop estimates, or invoice prices; the reason for use of overhead rates which depart significantly from experienced rates (reduced volume, a planned major rearrangement, etc.); or justification for an increase in labor rates (anticipated wage and salary increases, etc.). Identify and explain any contingencies which are included in the proposed price, such as anticipated costs of rejects and defective work, or anticipated technical difficulties.

3. Indicate the rates used and provide an appropriate explanation. Where agreement has been reached with Government representatives on the use of forward pricing rates, describe the nature of the agreement. Provide the method of computation and application of your overhead expense, including cost breakdown and showing trends and budgetary data as necessary to provide a basis for evaluation of the reasonableness of proposed rates.

4 If the total royalty cost entered here is in excess of \$250 provide on a separate page (or on DD Form 783, Royalty Report) the following information on each separate item of royalty or license fee: name and address of licensor; date of license agreement; patent numbers, patent application serial numbers, or other basis on which the royalty is payable; brief description, including any part or model numbers of each contract item or component on which the royalty is payable; percentage or dollar rate of royalty per unit; unit price of contract item; number of units; and total dollar amount of royalties. In addition, if specifically requested by the contracting officer, a copy of the current license agreement and identification of applicable claims of specific patents shall be provided.

5. Provide a list of principal items within each category indicating known or anticipated source, quantity, unit price, competition obtained, and basis of establishing source and reasonableness of cost.

D. NAC shall prepare quarterly R&D Status Reports, a mid-term Technical and a Final Report. These reports are to be prepared and submitted IAW the memorandum of 1 July 1976, Subject: "Revised ARPA Order General Requirements."

E. If the optional task 4 is funded, NAC will complete the documentation and PRSIM transfer within six months of start of work on Task 4, but not earlier than twelve months from the start of this contract.

Message 847 10993 1 MAR 78
 Mail from USC-ISIE rcvd at 1-MAR-78 1045-PST
 From: CENCOMS-F4 at USC-ISIE
 To: KAHN at ISI
 Cc: CERF at ISI, CENCOMS-F4 at ISIE
 Subject: REVISED SOW FOR NAC IN FY-78

17 MAR
 → ON KAHN
 THIS LOOKS
 FINE TO
 ME
 NCR

DR. KAHN,

File NAC

ENCLOSED IS THE REVISED SOW FOR NAC IN FY-78. PLEASE NOTE THAT NOW ALL THE USER MODEL DOCUMENTATION APPEARS IN TASK 4. OTHER TECHNICAL CHANGES INCLUDE THE REQUIREMENTS FOR:

1. THE USE OF TOP'S AND LOCAL ROP'S FOR ROUTING OF MOBILE UNITS.
2. THE CAPABILITY FOR THE MODIFIED ALOHA CHANNEL ACCESS ALGORITHM IN PRSIM.

ADDITIONALLY, I HAVE RE-WRITTEN TASK 3 (EXPERIMENTAL NETWORK DESIGN) TO REFLECT YOUR COMMENTS. I AM STILL A LITTLE CONFUSED REGARDING NAC'S PREVIOUS WORK IN THIS AREA. THE REVISED NAC PROPOSAL, DATED 2 DEC. 77, CLEARLY STATES IN TASK 1.1 THE FOLLOWING:

- "1. DEVELOP AN ALGORITHM FOR FLOW ASSIGNMENT.....
 2. DEVELOP A TOPOLOGICAL DESIGN ALGORITHM
 3. DEVELOP A TOPOLOGICAL DESIGN ALGORITHM FOR....LOW CAPACITY
AND FOR HIGH CAPACITY....."

ADDITIONALLY, THE MODEL PRSIM, AS I UNDERSTAND IT, IS ONLY A PERFORMANCE SIMULATOR. THE OUTPUTS ARE STATISTICAL COLLECTIONS OF ETE DELAY, NET LOAD, BUFFER/TERMINAL/CHANNEL UTILIZATION, ET. AL. IT WILL NOT TELL YOU HOW MANY NETS (SUBNETS) ARE NEEDED, OR HOW MANY ADDITIONAL TERMINALS WOULD BE REQUIRED TO MEET SPECIFIED THROUGHPUT ETE DELAY, OR SURVIVABILITY FIGURES.

FINALLY, THE REQUIRED REPORTING OF WORK (DELIVERABLES IN THE SOW) HAS BEEN UPDATED TO REFLECT THE REQUIREMENTS OF PARA. 5 OF YOUR ARPA ORDER 3549, DATED 16 JAN. 78. HOWEVER, DO WE REALLY NEED A MID- TERM REPORT AS REQUIRED IN THAT ARPA ORDER?

I WILL WAIT FOR YOUR COMMENTS BEFORE SENDING THIS SOW TO NAC.

BUD

STATEMENT OF WORK FOR NAC IN FY-78

TASK 1 - MODEL UPDATE, REFINEMENT, AND VALIDATION

- A. THE EXISTING NAC MODEL PRSIM WILL BE UPDATED AND REFINED TO

803549

PROVIDE A VALID AND REALISTIC MODEL OF CURRENT / FUTURE PRN. THE PRSIM MODEL WILL BE UPDATED AND REFINED TO INCLUDE:

1. INTEGRAL RELAY CAPABILITY (TERMINALS MAY ACT AS REPEATERS FOR PACKETS ALREADY IN THE NETWORK)

2. PACKET ROUTING/ALTERNATE ROUTING

(A) IMPLEMENT IN PRSIM MODIFICATIONS TO HOP PROTOCOL FOR DIRECT POINT-TO-POINT ROUTING, AND ALTERNATE ROUTING OF INFORMATION, CONTROL, AND ACKNOWLEDGEMENT PACKETS. THOSE MECHANISMS USED TO IMPLEMENT THE ROUTING AND ALTERNATE ROUTING IN THE MODEL PRSIM WILL BE ACCURATE REPRESENTATIONS OF THOSE USED IN THE ACTUAL PRN. THE HIERARCHICAL ROUTING WILL ALSO BE RETAINED IN THE MODEL, AND BE USED OPTIONALLY IN THE SIMULATION.

(B) IMPLEMENT IN PRSIM A PROCEDURE FOR HANDLING AND ASSIGNING POINT-TO-POINT ROUTES, AND ALTERNATE ROUTES BY GOOD NEIGHBOR TABLES, AND LOCAL ROP'S.

3. ENHANCEMENT OF REPEATER/TERMINAL MODEL

(A) MODIFY REPEATER/TERMINAL MODEL TO ACCOUNT FOR PREAMBLE DETECTION

(B) MODIFY REPEATER/TERMINAL MODEL TO ACCOUNT FOR NON-ZERO TIME CARRIER SENSE DELAY (RECEIVE AFTER RECEIVE, RECEIVE AFTER TRANSMIT) WITH TYPICAL VALUES TAKEN FROM PR EQUIPMENT.

(C) MODIFY REPEATER/TERMINAL MODEL TO INCLUDE ACCURATE REPRESENTATION OF BOTH TCP AND SPP ETE PROTOCOL, INCLUDING TIME-OUTS, RETRANSMIT TRIES, BUFFERING, AND WINDOWING.

(D) MODIFY REPEATER/TERMINAL MODEL TO ALLOW MOBILE COMMUNICATION WHILE TRANSMITTING/RECEIVING PACKETS. (THE TERMINALS MAY BE INSTALLED IN HELICOPTERS, PLANES OR OTHER MOBILE UNITS). TO AID PACKET ROUTING FROM MOBILE TERMINALS, TOP'S AND DROP'S WILL BE ACCURATELY REPRESENTED IN THE MODEL.

(E) EXPAND THE SET OF CHANNEL ACCESS ALGORITHMS TO INCLUDE THE MODIFIED ALOHA SCHEME.

B. THE MODEL PRSIM WILL ALSO BE VALIDATED TO THE MAXIMUM EXTENT FEASIBLE BY COMPARISON TO THE SAN FRANCISCO BAY AREA TESTBED. TO PROVIDE THIS VALIDATION, THE MODEL PRSIM WILL BE CONFIGURED TO REPRESENT SPECIFIC SCENARIOS SET UP IN THE THE BAY AREA TESTBED, AND THE VALUES OBTAINED BY THE SIMULATION

WILL BE COMPARED WITH VALUES OBTAINED FROM MEASURED PERFORMANCE DATA. ARPA, OR ARPA DESIGNATED ORGANIZATION WILL SUPPLY THE SPECIFIC SCENARIO(S) TO BE USED AND THE MEASURED TEST RESULTS. NAC WILL MAKE A REASONABLE EFFORT TO EXPLAIN ANY AND ALL DISCREPANCIES BETWEEN SIMULATED AND MEASURED DATA, AND THE PRSIM MODEL WILL BE MODIFIED AS APPROPRIATE.

TASK 2 - MILITARY SCENARIO TO BE USED WITH MODEL

A. BASED ON DISCUSSIONS WITH ARPA, AND OTHER ORGANIZATIONS SELECTED BY ARPA, CONSTRUCT USER PROFILES, REQUIREMENTS, AND A TRAFFIC DATA BASE FOR THE SPECIFIC SCENARIOS SELECTED. THE INPUT USER DATA BASE WILL INCLUDE BUT NOT BE LIMITED TO:

1. GEOGRAPHIC LOCATIONS (X,Y,Z COORDINATES) OF MILITARY UNITS (REAL OR FICTITIOUS)
2. AN ACCURATE DIGITIZED TERRAIN MAP ON WHICH UNITS OPERATE
3. A DIGITIZED TERRAIN AND PROPAGATION CONNECTIVITY DESCRIPTION FOR ALL UNITS OPERATING ON THE TERRAIN MAP ABOVE.
4. A REALISTIC TRAFFIC PROFILE (USER MESSAGE DESCRIPTION)
5. A DESCRIPTION OF THE MOBILITY OF MILITARY UNITS
6. A DESCRIPTION OF THE CHANNEL ERROR RATE.

B. THE MODEL PRSIM WILL BE MODIFIED TO ACCEPT THE INPUT USER PARAMETERS AS DESCRIBED ABOVE. MAKE MODIFICATIONS SO THAT CHANGES TO INPUT DATA BASE CAN BE MADE WITH MINIMUM IMPACT ON PRSIM, AND WITH MINIMUM EFFORT TO THE PERSON USING THE MODEL.

C. DEMONSTRATE THAT THE MODEL PRSIM WITH THE INPUT DATA BASE IS FULLY OPERATIONAL AND DEBUGGED. THE INPUT USER DATA MAY BE REAL OR ARTIFICIALLY CONSTRUCTED.

TASK 3 EXPERIMENTAL NETWORK DESIGN

A. THE MODEL PRSIM, DEVELOPED AND REFINED UNDER TASK 1, WILL BE USED WITH THE DATA BASE COLLECTED UNDER TASK 2, TO DESIGN A MILITARY PACKET RADIO NETWORK FOR SELECTED SCENARIOS. GIVEN THE LOCATIONS, TRAFFIC PATTERNS AND STATISTICS, AND CONNECTIVITY OF UNITS (MILITARY TERMINALS), AND THE DESIRED THROUGHPUT, MAXIMUM ETE DELAY, AND SURVIVABILITY REQUIREMENTS, THE MODEL WILL DETERMINE THE FOLLOWING NETWORK PARAMETERS:

1. NETWORK TOPOLOGY - THE NUMBER OF NETS OR SUBNETS REQUIRED INCLUDING THE NUMBER OF STATIONS AND LOCATIONS

2. INFORMATION FLOW - TO DETERMINE INFORMATION FLOW BETWEEN TERMINALS/ REPEATERS IN THE NETWORK.

3. CAPACITY - THE REQUIRED TRANSMISSION BANDWIDTH OF TERMINAL/ REPEATERS - TO INCLUDE A MARGIN FOR FUTURE GROWTH

4. REQUIREMENTS FOR ADDITIONAL HARDWARE (IF REQUIRED, E.G. RELAY OR HIGHER POWER) TO EITHER EXTEND RANGE OR PROVIDE ADDITIONAL CAPACITY IN AREAS OF HIGH TRAFFIC DENSITY, OR TO PROVIDE ADDITIONAL SURVIVABILITY.

B. THE MODEL WILL BE USED TO DESIGN A PACKET RADIO NETWORK FOR SELECTED MILITARY SCENARIOS. THE NETWORK DESIGNS WILL MEET THE NETWORK REQUIREMENTS OF THROUGHPUT, MAXIMUM ETE DELAY, AND SURVIVABILITY, AND REFLECT THE USER REQUIREMENTS OF THE USER DATA BASE AS IN TASK 2.A. THE DESIGN WILL BE CONSTRUCTED SO THAT CONSTRAINTS IMPOSED ON ITEMS 1 THROUGH 4 ABOVE MAY BE USED, AND NETWORK DESIGN WILL THEN PROVIDE SOLUTION BASED ON THOSE CONSTRAINTS.

C. A SENSITIVITY ANALYSIS SHALL BE PERFORMED WITH RESPECT TO ALL CRITICAL SYSTEM PARAMETERS AND REQUIREMENTS IN THE DESIGN ABOVE. SENSITIVITY ANALYSIS SHALL INCLUDE VARIATIONS IN CONNECTIVITY, TRAFFIC GENERATION RATES, CAPACITY, AND SURVIVABILITY REQUIREMENTS.

TASK 4 - MODEL TRANSFER TO THE ARMY, AND PREPARATION OF USER DOCUMENTATION

A. THE MODEL PRSIM, WITH THE NETWORK DESIGN FEATURES ABOVE IN TASKS 1, 2, AND 3 WILL MODIFIED TO BE FULLY OPERATIONAL AND DEBUGGED ON A SELECTED COMPUTER SYSTEM. (THE SYSTEM TYPE WILL BE SUPPLIED SHORTLY.)

B. DOCUMENTATION FOR TASK 1-- USER DOCUMENTATION

THE MODEL PRSIM WILL BE DOCUMENTED TO ALLOW A FORTRAN PROGRAMMER TO USE THE MODEL INTELLIGENTLY. A DESCRIPTION OF ALL MODEL INPUTS (INCLUDING THOSE NECESSARY TO MAKE THE MODEL AND USER DATA BASE WORK TOGETHER) WILL BE PROVIDED, INCLUDING FORMAT, TYPICAL VALUES, AND ACCEPTABLE RANGES. A DETAILED DESCRIPTION OF ALL MODEL OUTPUTS WILL ALSO BE PROVIDED, ALONG WITH SUFFICIENT EXPLANATIONS (DEFINITIONS) SO THAT THE SIMULATION RESULTS MAY BE INTELLIGENTLY INTERPRETED. AN OVERVIEW OF THE INTERNAL WORKINGS OF THE MODEL WILL ALSO BE SUPPLIED TO AID IN THE INTERPRETATION OF THE SIMULATION RESULTS. A THOROUGH DISCUSSION OF THE SIMULATION ERROR TERMINATIONS WILL ALSO BE PROVIDED,

TO ALLOW A FORTRAN PROGRAMMER TO EITHER CORRECT THE ERROR OR CHANGE THE INPUT DATA TO RE-RUN THE SIMULATION.

C. DOUMENTATION FOR TASK 2--USER DOCUMENTATION

DOCUMENTATION WILL BE PROVIDED SO THAT A FORTRAN PROGRAMMER WILL CAN DEFINE AND ENTER A SCENARIO TO THE MODEL, RUN THE MODEL, AND INTELLIGENTLY INTERPRET THE SIMULATION RESULTS.

DELIVERABLE ITEMS- FOR TASKS 1, 2, AND 3.

A. PROVIDE A BRIEFING TO ARPA AND CORADCOM DESCRIBING THE RESULTS OF ALL TASKS WITHIN FIVE MONTHS OF START OF WORK.

B. PROVIDE A FINAL WRITTEN REPORT TO ARPA/CORADCOM DESCRIBING THE RESULTS OF ENTIRE PROJECT WITHIN EIGHT MONTHS OF START OF WORK. THE REPORT WILL INCLUDE AS A MINIMUM:

1. FROM TASK 1, NAC WILL PROVIDE THE COMPARISONS OF SIMULATION RESULTS TO THE MEASURED TEST DATA.

2. FROM TASK 2, NAC WILL PROVIDE A DETAILED SUMMARY OF THE COLLECTED USER DATA BASES FOR THE SPECIFIED MILITARY SCENARIOS.

3. ALSO FROM TASK 2, NAC WILL PROVIDE A VERIFICATION THAT THE MODEL CAN ACCEPT THE MILITARY USER DATA BASE AS INPUTS, OPERATE ON THOSE INPUTS, AND CORRECTLY PERFORM THE SIMULATION.

4. FROM TASK 3, NAC WILL PROVIDE THE RESULTS OF THE PACKET RADIO NETWORK DESIGN AS APPLIED TO THE SPECIFIED MILITARY SCENARIOS. THE NETWORK DESIGN RESULTS WILL INCLUDE THE NETWORK TOPOLOGY, MAXIMUM SIMULATED ETE DELAY, INFORMATION FLOW, CACITY AND ADDITIONAL HARDWARE TYPE (STATIONS OR REPEATER/TERMINALS) AND LOCATIONS. THE STATISTICAL OUTPUTS OF THE MODEL PRSIM WILL ALSO BE PROVIDED.

5. FROM TASK 3, NAC WILL INTERPRET THE RESULTS OF THE NETWORK DESIGNS FOR SELECTED SCENARIOS IN (4) ABOVE. NAC WILL MAKE AN EFFORT TO EXPLAIN ANY SHORT COMINGS OR INCONSISTENCIES IN THE NETWORK DESIGNS.

6. FROM TASK 3, NAC WILL PROVIDE EXPLANATIONS OF THE NETWORK DESIGN APPROACHES USED IN THE DESIGN OF THE MILITARY PACKET RADIO NETWORK. LIMITATIONS, POTENTIAL SHORT-COMINGS THAT MAY EXIST IN THE NETWORK DESIGN ALGORITHM WILL BE EXPLAINED TO THE MAXIMUM EXTENT FEASIBLE.

7. FROM TASK 3, NAC WILL PROVIDE DISCUSSIONS AND RESULTS OF THE SENSITIVITY ANALYSES FOR EACH OF THE NETWORK DESIGNS.

C. BRIEF WEEKLY PROGRESS REPORTS FOR EACH TASK WILL BE SUBMITTED VIA THE ARPANET. A MONTHLY REPORT, VIA THE ARPANET WILL ALSO BE SUBMITTED DOCUMENTING PROGRESS AND PROBLEM AREAS.

D. NAC SHALL PREPARE QUARTERLY R&D STATUS REPORTS, A MID-TERM TECHNICAL AND A FINAL REPORT. THESE REPORTS ARE TO BE PREPARED AND SUBMITTED IAW THE MEMORANDUM OF 1 JULY 1976, SUBJECT: "REVISED ARPA ORDER GENERAL REQUIREMENTS."

1PT
AO/3549
Col Russell

Chronology of AO Actions

	DATES	
MRAO Rec'd in PM		AO Ret'd from Dir to Tech Off thru PM
Resubmission (MRAO) Rec'd in PM		Resubmission Rec'd in PM
Fw'd to Dir for Signature		Resubmission to Director
Ret'd from Director's Office		Ret'd from Director's Office

UNSTEIN

Schle
13 Jan

This is a part of overall
jointly funded packet
radio program that DARPA
alone is funding.

1. Braunstein, TDY 13 Jan

MNEY

*and is not
being funded
by program
14/1/78*

(Signed) Carl F. Romney

16 JAN 1978

SSUM

This ARPA Order/ARPA Order Amendment
has been signed and shown to the undersigned.

Ed Schle
Program Management Officer

1/17/78
Date

SUMMARY OF PROPOSED TASKS AND COMPLETION SCHEDULE

1.1 SUPPORT OF EXPERIMENTAL TEST BED AND SYSTEM DESIGN

1. Develop an algorithm for flow assignment in local distribution networks. The algorithm determines multiple labels for repeaters, which maximize the throughput. The labels are a function of topology (including number of stations) and the traffic pattern. One criterion that will be used for hierarchical routing and uniform traffic pattern is a convex combination of the minimum number of hops and minimum number of interfering repeaters along the paths assigned.
2. Develop a topological design algorithm for a stand-alone packet radio system. Given locations of terminals and traffic requirements, transmission ranges for packet radio units, topographies and physical system constraints, determine the organization, location and deployment of stations and repeaters which satisfy traffic delay, connectivity, and survivability constraints with the fewest number of redundant packet radio units.
3. Develop algorithms for topological design of an area coverage system. In this case terminal and host locations are not known and these devices are assumed mobile within the area for which the system is designed. Two problems will be solved:

Low throughput system: connectivity (or reliability) constraint; the capacity problem is not solved.

High throughput system: Requires incorporation of routing and capacity assignment.

4. Codify and integrate the solutions to subtasks 1, 2, and 3 into an overall methodology for packet radio systems for local distribution area.

5. Extend and integrate the packet radio reliability/ survivability techniques previously developed by NAC with the system approach developed in subtask 4.
6. Modify routing procedures within Packet Radio Simulation Program as follows:
 - 6.a Implement in Simulation Program modifications to hop protocol for acceptance and acknowledgement of alternate routed packet independent of hierarchy.
 - 6.b Implement a station procedure for handling these general alternate routed packets.
7. Based on discussions with ARPA and other organizations selected by ARPA, construct user pro-files, requirements and a traffic data base for the specific test bed scenarios to be studied.
8. Extend the Simulation Program's traffic generation capabilities to incorporate the characteristics of users identified in subtask 7.
9. Apply the results of subtasks 1-5 to the specific test bed scenarios investigated in subtask 7.
 - 9.1 Determine feasible network organizations to maintain connectivity and meet user requirements. Determine potential numbers and locations of stations, repeaters and terminals.
 - 9.2. Perform a capacity and traffic analysis to identify the levels of traffic that can be accommodated by the system configurations developed.
 - 9.3 Perform sensitivity analyses with respect to critical system parameters and requirements. These sensitivity analyses will be conducted with respect to several scenarios constructed jointly with ARPA. Representative scenarios include: possible destruction of stations, elimination of sections of the network due to jamming, etc.

10. Investigate possible operational and maintenance issues such as control of user access to the network and packet radio unit replacement policies.
11. Identify, where appropriate, enhancements to the packet radio system which can lead to substantial performance improvement in system operation for the specific scenarios examined.
- 12a. Provide a briefing to ARPA describing the results of subtasks 7 and 9 within six months of start of work.
- 12b. Provide a written report to ARPA describing the results of the entire project within eight months of start of work.

TASK COMPLETION SCHEDULE

Task Number 1	MONTHS							
	1	2	3	4	5	6	7	8
1. Flow Assignment Algorithm		X						
2. Fixed Location Design		X						
3. Area Coverage Design			X					
4. Methodology Integration				X				
5. Reliability/Survivability				X				
6. Hierarchical routing			X					
7. User Profiles		X						
8. Traffic Generation			X					
9.1 Configuration Analysis				X				
9.2 Capacity and Traffic Analysis				X				
9.3 Sensitivity Analysis						X		
10. Operational Issues							X	
11. Enhancements							X	
12a. ARPA Briefing						X		
12b. Report								X

